

REMARKS

This is in response to the Office Action dated January 9, 2009. In the Office Action, claims 1-6 are pending and stand rejected. Applicants have amended claims 1, 2, 3 and 5. Support for these amendments is found in the Specification at paragraph [0016] of the present application, US 2006/0094605. No new matter was added.

Rejections based on 35 U.S.C. 112, second paragraph

The Office Action rejected claims 1-2, 4 and 6 under 35 USC § 112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention. The Office Action stated that the claims 1-2, 4 and 6 require that the process be carried out by "thermally processing" and that the thermally processing is not defined and it is not clear what temperature is sufficient for "thermally processing".

Applicants submit that this rejection is moot in light of the claim amendments. Claims 1 and 2 have been amended to include the limitation "of 150 to 220°C". This limitation originally present in claims 3 and 5 is now included in claims 1 and 2, respectively. Since the Examiner has not rejected claims 3 and 5 for indefiniteness, Applicants believe that the newly amended claims are no longer indefinite under 35 U.S.C. 112, second paragraph.

In light of this amendment, Applicants request the removal of rejections based on 35 U.S.C. 112, second paragraph.

Rejections under 35 USC § 103 in view of US 4,283,295 (DeVries et al., hereinafter D1) and US 2004/0259945 (Brewer et al., hereinafter D2).

The Office Action rejected claim 1 under 35 U.S.C 103(a) as being unpatentable over D1 in view of D2. The Office Action asserts that carrying out a reaction between tetrathiomolybdate and succinimide in accordance with a variant of the method according to claim 1 of the instant invention (in which salt of thiomolybdic acid is subjected to thermal treatment in the presence of a second modifier and then a first modifier is added) is disclosed in D1.

A distinction of this variant of the invention according to claim 1 as compared with D1 is considered by the Examiner to be that in D1 the further addition of a tetraalkylammonium first

modifier to the obtained mixture is not described. However, the Examiner concludes that such an addition is obvious from the source US 2004/0259945 (Brewer et al., D2).

As is well known in this field of the art, additives to lubricant oils based on molybdenum compounds are polyfunctional, i.e., together with antifriction also have other useful properties. In particular, they are antioxidants, give the oils antiwear properties etc. (see, for example, the "Background of the Invention" section in the instant application).

Although a broad range of effects, achieved with the aid of compositions of additives, obtained by the method in accordance with D1 is presented in D1 (col. 2, lines 11-18), it follows from the materials of D1 that the actual task in D1 is the preparation of additives with the properties of antioxidants. So, "new lubricating oil compositions containing antioxidant molybdenum compounds" is indicated in the "Field of Invention" section (col. 1, lines 11-12). It is also indicated in the abstract of D1 that "Antioxidant additives for lubricating oil are prepared" It should also be noted that, although methods for measuring different characteristics of the prepared additives are indicated in D1, concrete numerical data presented in the table (column 7) for additives prepared in example 1 are presented only in respect to tests on antioxidant properties (Oxidator B test), and also for tests on corrosivity (ASTM D-130) and wear resistance (ASTM D-2266), while data on the friction coefficient are not presented. So, the invention in accordance with D1 is directed in the first place to improvement of the antioxidant characteristics of molybdenum-containing additives and lubricant oils.

Contrary to this, the aim of the instant application is explicitly defined as the use of molybdenum-containing materials as additives in lubricating materials for reducing the friction coefficient" (paragraph [0002] of the present application). The achieved effect is indicated in paragraph [0048]: "the proposed method makes it possible to prepare an antifriction additive on the basis of surface-modified nanosized particles of molybdenum trisulfide, this additive ... effectively reducing the coefficient of friction between the metal surfaces and increasing the critical load," and is confirmed by the data on tribologic tests (paragraph [0047]).

In addition to the different aims of the instant application and D1, Applicants submit that there are a number of distinct differences between the present invention and the cited art. First, in the instant invention the salt of thiomolybdic acid of the general formula $M_2MoS_{4-x}O_x$, where

M is NH₄, Na, x is 0-3, is used as the starting molybdenum-containing reagent. It is clearly defined in D1 that ammonium tetrathiomolybdate, (NH₄)₂MoS₄, is used as the starting molybdenum-containing reagent. So, the use of mixed salts – oxythiomolybdates, i.e., the salts of the general formula M₂MoS_{4-x}O_x, where x > 0, as starting components is not foreseen in D1.

Second, in accordance with D1, the presence of a polar promoter is required in the reaction of ammonium tetrathiomolybdate and a nitrogen-containing compound (in particular, succinimide) (see D1, col. 2, lines 3-7; claim 1; Example 1). Water is the most preferable promoter (D1, col. 2, line 42), and only the use of water as a promoter is illustrated in the only concrete example of realization of the invention, which is presented in D1 (see col. 6, Example 1).

In contrast, in the present invention, only organic polar solvents are indicated in the specification (paragraph [0016]) and in the set of claims (claims 4 and 6) as suitable polar solvents: "methanol, ethanol, propanol, isopropanol, n-butanol, isobutanol, 2-butanol, acetone or benzene is used as the solvent." It is also noted that only organic solvents are used in the examples, presented in the specification, of realization of the methods according to claims 1 and 2. Furthermore, it is indicated in the specification (paragraphs [0018], [0048]) that: "The product prepared by any variant of carrying out the method is filtered in order to isolate the solid admixtures and to remove the residues of volatile organic solvents under vacuum. The whole process of preparation may be carried out in one pot, - without involving large amounts of organic solvents." This also shows that the use of water as a solvent is not presumed in the instant application. Thus, the Applicant contends that the introduction of this feature into claim 1 is justified and does not constitute new matter.

In the method according to the currently amended claim 1, there is no direct indication to the necessity for use of a "polar promoter." On the other hand, in accordance with the method according to claim 1, the reaction of a molybdenum salt and succinimide is carried out "in a polar solvent," so it would be possible to state that such a solvent simultaneously carries out the role of the "polar promoter" in D1. However, as follows from the aforesaid, water is the preferable promoter in D1, while in accordance with amended claim 1 only non-aqueous polar solvents are used. Thus, water is excluded from the polar solvents used in the method. Such an

exclusion is due to the fact that in the presence of water, salts of thiomolybdenum acid are subjected to hydrolysis, especially at higher temperature, which results in the formation of undesirable side products, in a substantial discharge of hydrogen sulfide (which is also noted in particular in Example 1 of D1), etc. Therefore, the presence of water is not desirable in the method according to the instant invention.

Third, in accordance with D1, the reaction of ammonium tetrathiomolybdate and a nitrogen-containing compound may be carried out in an inert diluent (col. 5, lines 8-9), although the presence of the latter is not obligatory. Non-polar diluents, which do not react with the ammonium tetrathiomolybdate, are indicated as suitable diluents. In particular lubricating oil and liquid compounds containing only carbon and hydrogen are typical diluents (col. 5, lines 35-37).

At the same time it is indicated in D1 that the reaction of ammonium tetrathiomolybdate and a nitrogen containing compound is carried out at temperatures from above that at which the reaction mixture becomes solid to reflux (col. 5, lines 28-30). So, in the case of higher temperatures the reaction should be carried out under conditions of reaction medium boiling/refluxing, which medium should therefore be liquid. Wherein "polar promoters" in D1 may be used in small amounts (as low as 0.1 mol of the promoter per mol of molybdenum), which are not sufficient to ensure the presence of a boiling (refluxing) medium. Furthermore, upon the use of the preferable polar promoter, i.e., water, the boiling temperature of which is 100°C, the temperature of the refluxing media of 150 to 220°C may be hardly achieved. So, it follows from the teachings of D1 that in the case where a reaction is carried out at higher temperatures corresponding to the temperature range of 150 to 220°C according to claim 1 of the instant invention, the presence of an inert diluent is essentially obligatory. This is also confirmed by the example of realization of the method in D1, where heating the reaction mixture is carried out to reflux at 155°C, after removal of the water, while the boiling (refluxing) medium is a mixture of oil from the starting solution of succinimide and added hydrocarbon thinner.

In the method according to claim 1 of the instant invention, the reaction is carried out at 150-220°C in a polar solvent medium, which distinguishes it from the method of D1 in which, as is evident from the aforesaid, heating at higher (above 150°C) temperatures takes place in a nonpolar diluent after removal of the polar promoter.

Fourth, it should also be noted that in D1, prior to carrying out the aforesaid heating at 155°C, several steps of heating at lower temperatures are carried out (at first to 75°C, then at 65°C for 45 min and further to 95°C with removal of water), wherein the greater part of these steps is carried out under nitrogen atmosphere, which is not required in the instant invention. Therefore, the method of the instant invention is simpler to use.

So, even as regards the first step, i.e., the interaction of the salt of thiomolybdic acid and the succinimide as the second promoter, the method in accordance with the instant invention and the method in accordance with D1 do not coincide to a significant degree.

Furthermore, as indicated by the Examiner himself, the most significant distinction of the method in accordance with the instant invention as compared with the method in accordance with D1 is the presence of an additional subsequent step consisting in adding a compound of tetraalkylammonium as a first modifier to the product of thermal processing. Such an addition is neither disclosed nor suggested in any manner in D1.

The product obtained as a result of realizing the method in accordance with the instant invention is "an antifriction additive on the basis of surface-modified nanosized particles of molybdenum trisulfide, the additive forming transparent, stable dispersions in hydrocarbons and petroleum oils, and also effectively reducing the coefficient of friction ... and increasing the critical load."

Thus, a person with ordinary skill in the art could not presume how the method of D1 should be modified in accordance with the objects of the instant invention, i.e., in order to form transparent, stable dispersions in hydrocarbons and petroleum oils while reducing the coefficient of friction, so as to obtain the first step of the method according to the instant invention (broaden the group of suitable starting substances by introducing therein oxythiomolybdates; exclude the use of a polar promoter; exclude the use of an inert nonpolar diluent upon thermal processing at temperatures of 150-220°C; use instead of that a polar solvent, which however is not water; simplify the method by excluding preliminary steps of heating to lower temperatures). Even more so, such a person skilled in the art, if pursuing the object of modifying the method of D1 in order to reduce the coefficient of friction, could not supplement the method of D1 by the step of

adding a first modifier – a tetraalkylammonium compound. A person skilled in the art would not have any motive to turn in that respect to the source D2, which on the whole relates to a completely different field of science (copper binding compounds used in medicine) and with regard to the subject of the instant invention only comprises information that tetraalkylammonium tetrathiomolybdate, such as tetrapropylammonium tetrathiomolybdate, is characterized by increased stability as compared with ammonium tetrathiomolybdate. The Examiner presumes that "it would have been obvious to one of ordinary skill in the art to further add a tetraalkylammonium salt modifier to the product of the tetrathiomolybdate and succinimide from D1 in order to convert the remaining tetrathiomolybdate compounds to the more stable tetraalkylammonium compounds". However, as shown above, during the development of the instant invention, a person skilled in the art would not have the problem of "converting the remaining tetrathiomolybdate compounds into more stable tetraalkylammonium compounds," since his aim should not be improvement of the antioxidant properties of the additive, but rather improvement of the antifriction properties thereof, and hereupon he would more probably need a most complete conversion of the starting tetrathiomolybdate compounds into the final modified nanoparticles of molybdenum trisulfide, imparting the desired properties to the obtained additives rather than any "stabilization" of these starting compounds. Accordingly, there would not be any reason for a person of ordinary skill in the art to refer to the source D2, and even more so to use the indication thereof that tetraalkylammonium tetrathiomolybdate, such as tetrapropylammonium tetrathiomolybdate, is characterized by increased stability in comparison to ammonium tetrathiomolybdate, for modification of the method of D1, resulting in the method according to the instant invention.

In light of the discussion above, Applicants submit that the claim 1 is not obvious over D1 in view of D2. Applicants respectfully request the removal of this rejection.

Rejections under 35 USC § 103 over US 4,400,282 (Singerman et al., D3), in view of US 4,343,746 (Anglin et al., D4)

The Office Action rejected claims 1-3 and 5 as being unpatentable over D3 in view of D4. The Examiner asserted that D3 discloses lubricating oils comprising a minor amount of a

tetrahydrocarbyl thiomolybdate, some of which contain tetrahydrocarbyl groups within the scope of the first modifier of claim 1. The Examiner further asserted that D3 discloses that tetrahydrocarbyl thiomolybdates are formed by reacting an alkali metal molybdic acid salt with a tetraalkylammonium salt as in the first step of claim 1 and that tetrahydrocarbyl thiomolybdates are formed by reacting an alkali metal molybdic acid salt with a tetraalkylammonium salt. The Examiner also asserted that D3 discloses that the tetrahydrocarbyl thiomolybdates are combined with a succinimide dispersant, meeting the limitations of adding the second modifier of claim 1 and also that the alkali metal thiomolybdates are prepared from a alkali metal thiomolybdate and hydrogen sulfide meeting the limitations of the molybdic acid salts and sulfur donor of claim 2. The Examiner identified that D3 does not disclose a sodium or ammonium thiomolybdate reactant or thermally processing the thiomolybdate with the tetraalkylammonium modifier. The Examiner alleged that D4 teaches that sodium and ammonium thiomolybdates are suitable starting materials for forming tetrahydrocarbyl thiomolybdates and that D4 teaches that temperature is not a critical factor in the reaction. The Examiner concludes that D4 discloses that it is convenient to carry out the reaction at room temperature but this does not constitute a teaching away from performing the reaction at elevated temperature and that the present invention would have been obvious to one of ordinary skill in the art.

Applicants assert that the preparation of a tetrahydrocarbyl ammonium thiomolybdate from cocodimethylammonium chloride and potassium thiomolybdate is described in example 1 of source D3 and a similar reaction with sodium and ammonium thiomolybdates is described in source D4. However, it is proposed that in both D3 and D4 such reactions be carried out in a mixture of water and organic solvent(s) (usually toluene and isopropanol, see examples 1 and 2 in D3, examples 1-7 in D4). Not one of the aforesaid sources requires or suggests the exclusion of water from the reaction mixture. This differs from the variant of the method according to claim 1 in accordance with the instant invention in which the reaction of a thiomolybdic acid salt with a tetraalkylammonium salt as the first modifier is carried out in a non-aqueous polar solvent, at a temperature of 150-220°C.

Further, in accordance with the method according to claim 1 of the instant invention a second modifier is mixed with the product of thermal treatment of the mixture of thiomolybdenum salt and the salt of tetrahydrocarbylammonium with the obtainment of a separate additive, which may later be added to lubricating oil. At the same time in accordance with D3, compositions of a lubricating material are claimed, a significant part of which comprises a base hydrocarbon lubricating oil. Tetrahydrocarbylammonium thiomolybdate, reducing the coefficient of friction, and a dispersant (in particular, a dispersant of the succinimide type) solubilizing the indicated tetrahydrocarbylammonium thiomolybdate in the hydrocarbon lubricating oil, are added to the lubricating oil. Wherein, as described in example 3 of D3, the aforesaid components are added directly to the hydrocarbon oil, i.e., without preliminarily mixing with each other and obtaining a separate ready additive. Wherein the Examiner refers to this example in particular as disclosing the method in accordance with the instant invention with the addition of a second modifier – succinimide.

The compositions of lubricating material prepared in D3, together with a dispersant should comprise one more component, in particular "sufficient amount of a zinc dialkyl dithiophosphate" (D3, col. 2, lines 40-44; claim 1) to effect solubilizing of the thiomolybdate in the hydrocarbon oil. The necessity for use of this combination (zinc dialkyl dithiophosphate and an ashless dispersant, in particular, succinimide dispersant) follows from the same example 3 in D3. It is shown here that with this combination the solubility of dicocodimethylammonium thiomolybdate in oil is complete, while in the presence of only a succinimide dispersant, without zinc dialkyl dithiophosphate, solubility is only "slight."

At the same time, in accordance with the instant invention, the introduction of zinc dialkyl dithiophosphate into the makeup of the additive is not required and is not presumed, which makes it possible to simplify the claimed method and make it less expensive. Wherein, as indicated in paragraph [0048]: "the proposed method makes it possible to prepare an antifriction additive on the basis of surface-modified nanosized particles of molybdenum trisulfide, this additive forming transparent, stable dispersions in hydrocarbons and petroleum oils." Moreover, "effectively reducing the coefficient of friction" is also thereby provided, which is evident from the presented data: the coefficient of friction provided by the additives according to the instant

invention is 0.060 – 0.067 (the table in paragraph [0047]) at room temperature (20°C), while in D3 the coefficient of friction is 0.085 – 0.119 (0.119 in the case of dicocodimethylammonium thiomolybdate) (col. 7, Table III) at 54°C. Wherein, the coefficient of friction tends to reduce when the temperature rises (which is evident, for example, from the same Table III in D3).

Thus, a person with ordinary skill in the art on the basis of D3, where the necessity for the presence of zinc dialkyl dithiophosphate is directly indicated, and no indications or suggestions are given on the possibility of excluding it from the composition of D3, could not make an obvious conclusion that such an exclusion is necessary or desirable. Even more so, that person could not thereby expect an improvement in the characteristics of the final product. It is clear that such exclusion does not in any manner follow from the sources D4 either, taken together or separately in combination with D3. Therefore, the invention, as claimed, is not obvious under D3 or under the combination thereof with D4.

The Examiner argues in support of his rejections to claim 2 that " the preparation of alkali metal thiomolybdates from alkali metal molybdate and hydrogen sulfide gas is described in the fragment from column 4, line 47 to column 5, line 2 in the Singerman document, which conforms with the features for salts of molybdic acid and a sulfur donor from claim 2 of the set of claims of the instant invention."

However, in the method in accordance with item 2 of the instant application "the nanosized particles of molybdenum trisulfide and/or derivatives thereof are prepared from salts of molybdic acid of the general formula M_2MoO_4 , where M is NH_4 , Na, and a sulfur donor, which is an inorganic sulfide or polysulfide of the general formula M'_2S_n wherein M' is NH_4 , Na, n is 1 – 4, or thiourea." So, the use of only hydrogen sulfide H_2S is provided as the sulfidizing agent in D3 for the preparation of thiomolybdate salts and there are no indications in respect to the use of inorganic sulfides or polysulfides in the form of sodium or ammonium salts as in the instant application in which, to the contrary, the use of hydrogen sulfide is not proposed. The same is true for the source D4, where "treating an aqueous alkaline solution of the corresponding molybdate salt with hydrogen sulfide" is proposed for the preparation of thiomolybdates of alkaline metals (D4, col. 2, lines 30-33). It should also be noted that *per se* the preparation of

thiomolybdates is not given consideration in either D3 or in D4 as the step of methods in accordance with the indicated sources. Thiomolybdates are used in D3 and D4 as ready starting reagents, and the reaction of the preparation thereof from molybdates and hydrogen sulfide is only mentioned as a standard method for the preparation thereof, which should be preliminarily realized (if any) prior to carrying out the methods in accordance with D3 or D4. Accordingly, concrete examples of the realization of such a preliminary step of preparing thiomolybdates are not provided at all in the aforesaid sources.

In view of the Examiner's rejections with respect to claim 2 and claims dependent from claim 2, the Applicant, first of all, believes that the arguments presented above in support of the inventive step of claim 1 over D3 and the combination thereof with D4 are also applicable in equal measure to claim 2. This is valid as regards the part of those sources which relates to the direct indication of D3 that in the compositions of lubricating material that are obtained in D3, together with a dispersant (in particular a succinimide dispersant), it is obligatory that zinc dialkyl dithiophosphate be present in order to provide sufficient solubility/dispersibility of particles of a molybdenum-containing additive in lubricant oils. This is contrary to the fact that in the methods according to claim 1 and claim 2 of the instant application, the presence of zinc dialkyl dithiophosphate is not required and is not presumed.

To the contrary, in the instant application upon realization of the methods according to claim 2, the preparation of thiomolybdates is carried out i) with the use of sodium or ammonium or thiourea as the sulfiding agent of inorganic sulfides or polysulfides and ii) simultaneously with treatment with the first modifier (with tetraalkylammonium salt). The advantages of this method, in particular the replacement of the dangerous and volatile hydrogen sulfide with the aforesaid nonvolatile sulfiding agents, and also simplification of the whole method by reducing the number of steps, is obvious to a person skilled in the art. At the same time it is noted that this approach is not disclosed in either D3 or in D4 and does not obviously follow from the aforesaid sources.

For the reasons discussed above, Applicants respectfully request the removal of rejections of claims 1-3 and 5 over D3 in view of D4.

Rejections under 35 USC § 103(a) over US 4,400,282 (Singerman et al., D3) in view of US 4,343,746 (Anglin et al., D4) and US 4,588,829 (Pan et al., D5).

The Office Action rejected claims 4 and 6 under 35 U.S.C. 103(a) over D3 in view of D4 and D5. The Examiner rejected claims 4 and 6 for the reasons stated above and asserted that D3 and D4 disclose a method of meeting the limitations of claims 1-2 but do not disclose the polar solvents recited in claims 4 and 6. The Examiner alleged that D5 discloses the conversion of ammonium thiomolybdate to tetrahydrocarbyl thiomolybdates in methanol meeting the limitations of the solvent of claims 4 and 6. The Examiner concluded that it would have been obvious to one of ordinary skill in the art to use the methanol of D5 as the solvent in order to avoid using the complex two-phase mixture of D3 and D4.

Applicants assert that the synthesis described in D5 is carried out at room temperature (heating the mixture is not mentioned). Therefore, a person of ordinary skill in the art, who would like to use this procedure in the method for preparing tetrahydrocarbylammonium thiomolybdate in accordance with D3 or D4, upon a transition from a water-organic mixture of solvents to methanol, would most probably use just room temperature, especially taking into account the indication in D4 that temperature is not a critical factor for the reaction and it is therefore convenient to carry out the reaction at room temperature. Obviously, this indication in D4 does not teach away or limit the possibility to carry out the reaction at higher temperatures, but as is clear from the aforesaid, in the case of modification of the method from D4 in accordance with D5, the desirability/preference of carrying out the reaction at room temperature is strongly supported by teachings of D5 as well. So, the source D3 in combination with the sources D4 and D5, together or separately, does not make it obvious to prepare tetrahydrocarbylammonium thiomolybdate in accordance with the methods according to claim 4 and 6 of the instant invention in a non-aqueous polar solvent, at a temperature of 150-220°C.

In view of all of the aforesaid reasons, the methods according to claims 4 and 6 are not obvious under D3 or under the combination thereof with D4 and/or D5.

It is believed that the claims, as written, are allowable and allowance of the claims is respectfully requested.

The Director is authorized to charge any fee deficiency required by this paper or credit any overpayment to Deposit Account No. 23-1123.

Respectfully submitted,

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